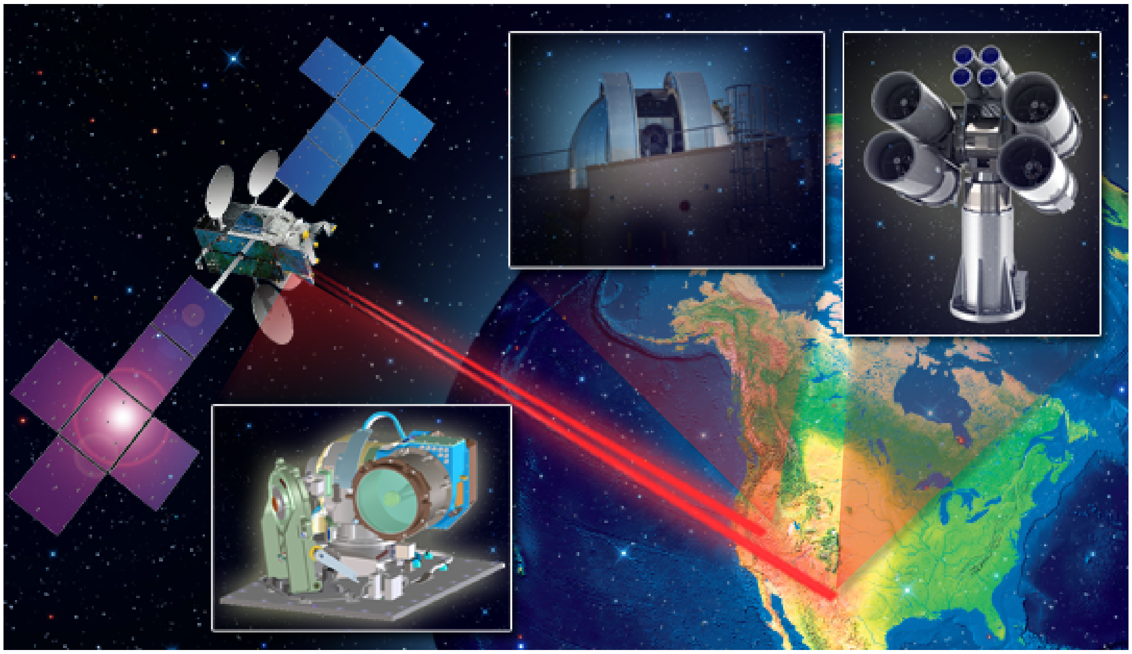
NASA facts

Laser Communications Relay Demonstration, The Next Step in Optical Communications



Since its inception in 1958, NASA has relied exclusively on radio frequency (RF)-based communications as the only viable medium for exchanging data between a mission and a spacecraft. From Apollo to more modern feats such as the Lunar Reconnaissance Orbiter (LRO), the principles and methods of communication have evolved and advanced. Today, with missions demanding communication with higher data rates than ever before, NASA is taking steps to embark on a new era of communication technology. The Laser Communication Relay Demonstration (LCRD) project will help pave the way, pioneering technologies that will enable the exchange of data through beams of light.

Transforming the way NASA communicates mission-critical information, LCRD will use lasers to encode and transmit data. Laser communications will allow communications rates 10 to 100 times faster than RF-based communication. In many instances, the amount of data transmitted back to Earth is bottlenecked through current methods limiting the science return.

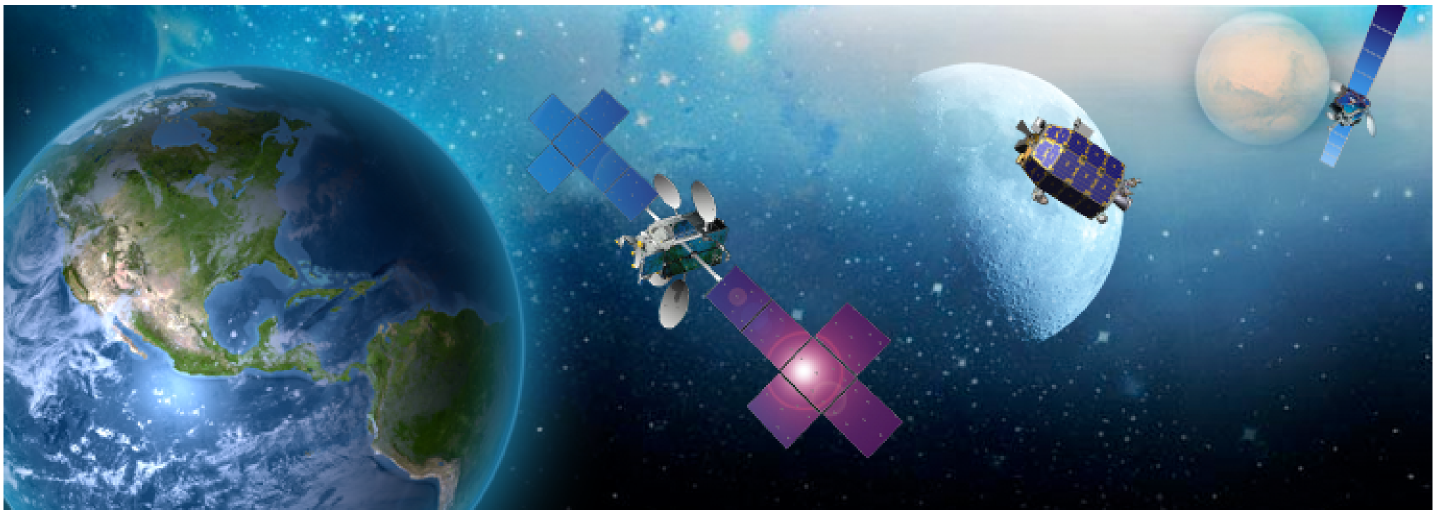
The wavelength of the laser light is shorter than radio waves and reduces the area the energy spreads as it travels through space. For example, a typical Ka-band signal from Mars spreads so wide that when it reaches Earth the diameter of the energy is many times larger than the diameter of the Earth. A typical optical signal, however, will spread only over the equivalent of a small portion of the United States, requiring less energy use and waste.

In addition, with a shorter wavelength there is significantly more bandwidth available for an optical signal, while radio systems are restricted because of limited bandwidth. Currently, NASA must coordinate with its national and international partners to ensure use of proper frequency bands that prevent interference during transmissions. In optical communication, this is not a concern. This increase in bandwidth will enable NASA to operate with no spectrum allocation constraints.

This leap in technology will allow spacecraft to send high-resolution science data across the solar system to scientists on Earth, affording researchers the opportunity to study other planets at the same level of depth as they study our own. From tracking storms to analyzing the environment and understanding climate change, laser communication will make it possible to establish a virtual presence on remote planets and other objects in the solar system. It will allow higher rates of communications that will be needed for future exploration. Space laser communications will also allow missions to use bandwidth-hungry instruments, such as hyperspectral imagers, synthetic aperture radar and other instruments with high definition and high data rate requirements.

Optical communication also has applications for near-Earth orbiting satellites. The needs of modern near-Earth missions are growing and will require high data volumes comparable to those needed for deep space missions. LCRD is considered a critical step toward the next generation Tracking and Data Relay Satellite (TDRS) system, which currently has a fleet of TDRSs in geo-synchronous orbit, relaying mission data to ground stations over RF signals. The next generation in communications satellite will supply both RF and optical services.

Just as data rates have steadily increased over time, the communications systems employed both in space and on the ground have been shrinking in size. During the early days of human spaceflight, NASA flew antennas that were seven feet in diameter aboard the Apollo spacecraft to communicate back to earth. When NASA launched LRO in 2009, its antenna was 2.5 feet in diameter. With the advent of optical communication, laser terminals aboard spacecraft can be as small as 4 inches. That is a staggering 5,625% reduction in area and a smaller footprint aboard valuable spacecraft real estate.



The same principle also applies to the ground-based optical communication receivers. During Apollo program, NASA used 180-foot diameter ground antennas to send and receive data during trips to the moon. LRO currently uses a 55-foot diameter antenna at White Sands, N.M., to transmit data to the ground. A precursor to LCRD, the Lunar Laser Communications Demonstration (LLCD), will demonstrate optical communication from lunar orbit using a ground receiver 39-inches in diameter.

LCRD is not NASA's first foray into optical communication. There have been numerous short-lived, low-data-rate demonstrations in the past, sometimes with international participation. Earlier this decade, there was pioneering work done for the Mars Laser Communications Demonstration, which never flew in space. Today, Massachusetts Institute of Technology's Lincoln Laboratory in Lexington, Mass., is developing for NASA LLCD, which will be the first high-rate demonstration of optical communications in space. It is also a short duration mission with limited operations. LCRD leverages the pioneering developments of LLCD with the goal of making them ready for mission critical long-term operations.

The LCRD team is led by NASA's Goddard Space Flight Center in Greenbelt, Md. Partners include NASA's Jet Propulsion Laboratory in Pasadena, Calif. and the Lincoln Laboratory. LCRD is a Technology Demonstration Mission funded through NASA's Space Technology Program. Using commercial partnerships, LCRD is expected to fly as a hosted payload on a commercial communications satellite developed by Space Systems/Loral of Palo Alto, Calif. Ground stations in California and New Mexico will test LCRD's invisible, near-infrared lasers, beaming data to and from the satellite as the mission refines the transmission process; studies different operational scenarios; and perfect tracking systems. They also will study the effects of clouds and other disruptions on communications, seeking to identify solutions including relay operations in orbit or backup receiving stations on the ground.

LCRD: Key Mission Facts

- The Laser Communications Relay Demonstration mission is NASA's first, long-duration optical communications mission.
- The project will help mature concepts and deliver technologies applicable to both near-Earth and deep space communication network missions.
- The investigation will enable a variety of robust, future science and exploration missions, providing a higher data rate and delivering more accurate navigation capabilities with reduced size, weight and power requirements.

LCRD is expected to be a cost-effective way to demonstrate optical communications and advanced networking concepts. It will leverage NASA's investments in optical communication technologies with minimal modifications to existing flight systems allowing the full use of optical communications and relay operations. In a two-year spaceflight operational environment, LCRD will demonstrate that optical communications can meet NASA's and other agencies' growing need for higher data rates using lower power and smaller communications systems onboard future spacecraft.

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For more detailed information on Optical Communication, see:
http://esc.gsfc.nasa.gov/267.html

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